

Introduction to Construction Tools and Equipment

Course Concept

Jason Wahlund

California Polytechnic State University
San Luis Obispo, California

The current Cal Poly Construction Management curriculum covers nearly all areas of the construction industry with a wide range of materials along with how, where and why they are used. However, no class is specifically geared towards educating students to learn about the tools and equipment that are required to complete most of the jobs in these industries. By offering a technical elective course that allows students to not only visualize but recognize what tools and pieces of equipment are most effective and acceptable for various applications, we can enable students to further understand issues of constructability and safety on jobsites. This paper will analyze student intellect about both basic and specialized forms of equipment utilized on projects, why that knowledge is important and what should be done to ensure new graduates are well-versed in this area of construction.

Key Words: Tools, Equipment, Safety, Curriculum, Construction Technology

Introduction

Since the inception of construction, before the adaption of scheduling, integrated project design, or even LEAN principles, tools and equipment have always been the most basic necessity for building. For every stage of a project, each task needs tools and equipment. Whether it's drilling holes into concrete with a rotary hammer drill, excavating to establish footings for a building, or cutting rebar with a portable bandsaw, tools and equipment are the backbone of the construction industry. However, one can notice when undergoing an undergraduate construction management program at any university, the fundamental concepts, safety knowledge, and construction technology surrounding tools in the workplace can be overshadowed by more managerial and theoretical ideals.

In Cal Poly's Construction Management (CM) program this type of overshadowing is prevalent. As a student who has taken all required courses to fulfill a bachelor's degree in CM, and who has had three internships prior to graduating, it has become clear that the hands on learning and technical skills generated through these internships has been the main source for students to gain crucial tools and equipment knowledge. Another topic that is barely covered in this department is tool safety, and the courses that do only lecture about logistical jobsite safety issues, rather than specific tool application safety. This is the case in CM 413, Jobsite Construction Management, where one of the assignments is to take the OSHA-10 class online. This OSHA certification process contains a vast amount of tool safety related questions in their videos and quizzes; however, this assignment isn't required to pass the class, and serves as a miniscule portion to the student's overall grade.

Advocacy for a specific tools and equipment class that teaches students hands on learning, proper tool usage, and safety requirements is something that could be invaluable to the students who are trying to stand out in the competitive job market today. A joint senior project produced by two previous Cal Poly students, Matthew Bramlett and Patrick Garcia, supported an interactive OSHA-30 class, where students would learn about topics like hazard communication, OSHA inspection procedures, industrial & bloodborne pathogens & much more" (Bramlett & Garcia). This class would have similar safety topics to the ones I am trying to establish, however, instead of being completely based on OSHA and safety regulations, it's primary goal would be general tools and equipment knowledge.

Based on survey data collected by Patrick Garcia, he found that many students at Cal Poly would be interested in taking a class that fulfills OSHA-30 classification. One of the questions in his student survey asked if the student

had completed their OSHA-10, OSHA-30 certificate, both, or neither. “Of the [28] respondents, 68% had their OSHA-10 certificate, 0% had only their OSHA-30 certificate, 4% had both their OSHA-10 and OSHA-30 certificate, and 28% had neither” (Garcia). This data shows that not all students are coming into the workforce with the amount of safety training that they could be if they were given the opportunity to take the OSHA-30 training course. This data was also collected in spring of 2018, so it is still pertinent to the research I will be conducting.

One of my primary objectives for my research is to identify the best overall structure for this class. Matthew Bramlett’s portion of constructing this interactive OSHA-30 class was to create a syllabus and lab breakdown structure. What was most interesting about this syllabus was that each week had a specific safety topic to be covered. For example, week two would be JHA/ Site Safety Plan Development, week 3 would be Scaffolding, etc. I could implement something similar in this class by covering a certain area of tools or equipment each week. However, only after conducting a survey and interview, which I will discuss in my methodology for this paper, will I be able to get a better picture for exactly how this class will be outlined.

In short, Patrick Garcia and Matthew Bramlett’s OSHA-30 topics course will help me decide what types of safety related subjects will be beneficial to this class. Nevertheless, the survey I plan to conduct will allow me to decide how much or how little safety related content should be implemented into this course. The research I am going to conduct is designed to see what information students are lacking in regards to tools and equipment knowledge, and from there, identify how this class should be structured.

Methodology

The methodology chosen is a mixture of qualitative and quantitative data. The quantitative portion of this research comes from a survey taken by 41 random construction management students at the Cal Poly University in San Luis Obispo, Ca. The qualitative data was produced from an industry leader working at Webcore. The interview focused on questions related to the importance of tools and equipment knowledge on the jobsite, current curriculum present at Cal Poly concerning tools and equipment knowledge and experience with accidents regarding equipment safety along with the causes of those accidents.

The objectives of the survey are to...

- Identify if a course concerning tools & equipment would be beneficial to the department
- Assess the areas of tools and equipment knowledge that students are familiar with and which they are unfamiliar with
- Develop potential topic ideas that aren’t being covered in current curriculum
- Determine if tools and equipment knowledge has a linear relationship with time

The objectives of the interview are to...

- Identify the significance of tools and equipment knowledge on the jobsite
- Decide how much hands on learning this course should have
- Reveal how learning about tools and equipment safety can prevent accidents
- Decide how the class will be structured as far as content

Survey

The survey consisted of 15 multiple choice and true or false questions with topics ranging from choosing a specific tool to completing a task to OSHA tools and equipment safety. All participants answered every question in the survey. Out of the 41 students six were 1st years, thirteen were 2nd years, eight were 3rd years, and fourteen were 4th years. Having an even spread of students with varying levels of construction experience will be important when

analyzing the data of this survey. The spread will make it easy to identify if there is a correlation between years spent in the construction management department at Cal Poly and tools and equipment knowledge.

5. You need to cut twenty 10' pieces of rebar into 6" dowels. What is the safest and most efficient tool needed to get the job done?

- a.) Oxyacetylene Torch
- b.) Angle Grinder
- c.) Chainsaw
- d.) Portable Bandsaw

Figure 1: Question 5 of the survey (Survey Monkey)

11. While working near flammable substances, one should avoid iron and steel hand tools.

- a.) True
- b.) False

Figure 2: Question 11 of the survey (Survey Monkey)

Figures 1 and 2 give an idea of the type of questions that were asked in the survey. Figure 2 specifically shows an example of one of the situational based questions that were asked for the first half of the survey, while Figure 3 shows an example of one of the safety related questions that took up the majority of the second half of the survey. Some of the situational questions I made myself based on previous internships I've had, and those that were safety related I pulled off different credible sites online (MySafetySign & ReliablePlant).

The first and last questions in the survey were not knowledge based but situational. The first question asked what year the student was, while the last asked if they felt the CM department sufficiently covers the various uses, applications, and safety requirements of tools and equipment on the jobsite. The goal of the remaining thirteen questions was to cover a broad range of tool applications concerning tools & equipment that are both common and specialized in all construction industries. By using resources accumulated through questions in CM 214 (Residential Construction), CM 313 (Commercial Construction), CM 314 (Heavy Civil Construction), CM 413 (Jobsite Management) and online resources. With the resources provided through these classes each question identifies a certain area industry of construction with a specific tool or piece of equipment involved.

There were many tools and pieces of equipment mentioned in the survey: Gradall, backhoe, portable bandsaw, angle grinder, insulating gloves, etc. Many of these small and heavy pieces of equipment are used on jobsites spanning across multiple industries, which was important, so all students had a fair shot if they had experience in other industries. Various situations were created to be able to ask which tool would be more effective, such as question 5 in Figure 1. Other examples of these situational-based questions included the removal of dirt, drilling holes into concrete and cutting sections of rebar. The other half of the questions that were safety related had to do with situations such as: means of egress in a trench, requirements for different types of jacks, protection for using pneumatic tools, etc. All of these questions link back to OSHA safety standards on the jobsite. These OSHA requirements are essential to know on the jobsite so that all employees are safe, and so that the companies many of these students are working for don't receive any fines for violating these standards.

Interview

The individual I chose to interview is a superintendent that works for Webcor throughout the Los Angeles area, his name is John Tuttle. He has ten years of experience in the field and has a wealth of tool and equipment knowledge required to complete nearly any task on a commercial construction jobsite. Finding the right person to interview for this course concept was vital in order to obtain the appropriate input for the content in this class. Someone that has been working in the construction industry for at least five years and has been responsible for jobsite management and safety were some of the factors in deciding who to interview. John hits both those requirements, and, speaking for someone who has been managed by a superintendent on jobsites before, knows the level of responsibility and knowledge a supervisor needs to have on the jobsite to be successful.

Results and Discussion

Survey

The first question that was asked in this survey was what the student's current year was. There were six 1st years, thirteen 2nd years, eight 3rd years, and fourteen 4th years who took the survey. My goal was to have a decent range of students with different class rankings to get a better understanding of the knowledge each class had. Since no individual group of class standings had more than thirty people, it was difficult to keep a consistent level of accuracy when analyzing trends in this particular data. With that being said the total amount of students who took the survey is well above thirty, which means it is safe to make assumptions about all construction management majors at Cal Poly.

Out of these 41 students who took the survey and based on the 13 technical questions they were asked, less than 50% of the students got more than half of the questions right. Putting this into context, there were only five questions in which the majority of students answered correctly. From three out of those five questions, less than 65% of the students got those questions correct. Most questions students struggled on were about evenly matched when comparing questions about tool and equipment applications versus tool and equipment safety.

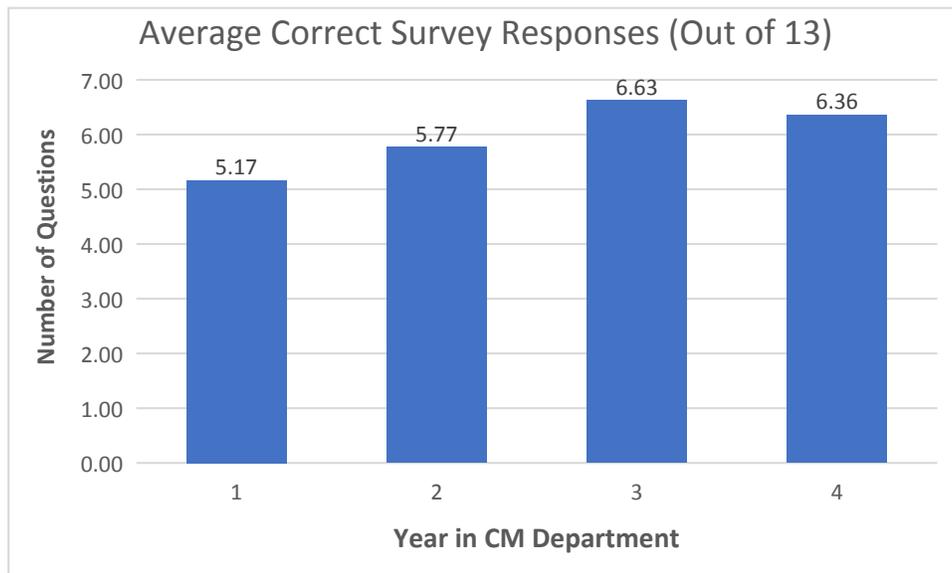
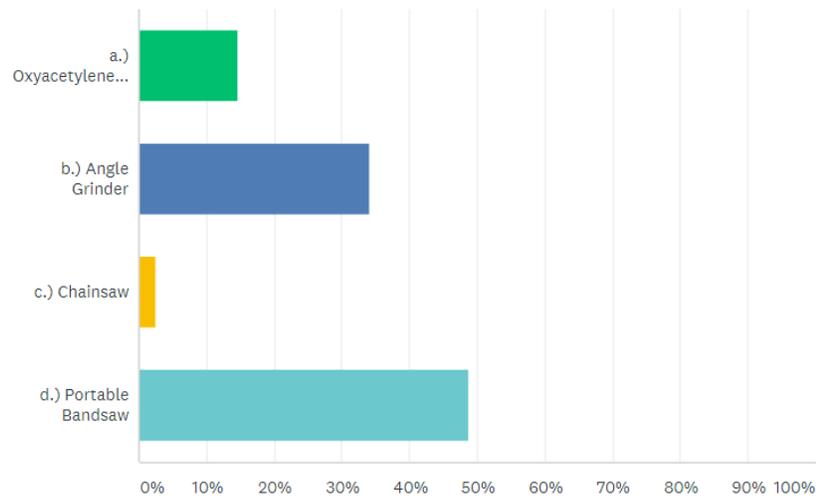


Figure 3: Survey Results Conducted in Excel

In Figure 3, there is a slight upward trend between years spent at Cal Poly and number of questions answered correctly on the survey. 1st years averaged approximately 5 correct answers, 2nd years 6, 3rd years 7 and 4th years 6.

Although there does not appear to be any strong correlation between years spent in the CM department and correct number of questions answered in the survey, this data does show that the average for all years is extremely low, considering there were 13 questions. The average of all students who took the survey was only 6 correct responses.

Looking at the first section of questions asked in the survey, which were situational based, and the second half of the questions asked in the survey, which were safety and OSHA related, neither section got significantly more questions right by students than the other. This could be because when learning about how to use tools and equipment properly, safety regulations concerning those tools go hand in hand. The knowledge students have gained while learning certain tools on the jobsite probably lead them to discover more about safety requirements in general. The issue is that these young, aspiring project managers do not fully understand the dangers of tools and equipment that are being implemented on the jobsite every day, which goes hand in hand with learning about how to properly use tools and equipment.



ANSWER CHOICES	RESPONSES
▼ a.) Oxyacetylene Torch	14.63% 6
▼ b.) Angle Grinder	34.15% 14
▼ c.) Chainsaw	2.44% 1
▼ d.) Portable Bandsaw	48.78% 20
TOTAL	41

Figure 4: Survey Responses to Question 5 (Survey Monkey)

Figure 4 reveals the responses for question 5 on the survey which asked what the most efficient and safest tool was to cut twenty 10' pieces of rebar into 6" dowels. The correct answer to the question is portable bandsaw. Although portable bandsaw was the most popular response the majority of students who took the survey still got this answer incorrect. This bar chart exemplifies how prevalent the absence of tool and equipment knowledge is in the CM department. If we had a class that went over the various uses, applications and safety requirements of tools and equipment on the jobsite, questions like number 5 on this survey wouldn't be difficult for students.

The data within this survey indicates beyond a reasonable doubt that tools and equipment knowledge is more than lacking in the CM department, and students should in some way, shape, or form should be exposed to it more often. From the results of the final question in the survey, approximately 51% of the students that took the survey do not think that the CM department at Cal Poly sufficiently covers the various uses, applications, and safety requirements

of tools and equipment on the jobsite. There seems to be no particular year at Cal Poly in which CM students would benefit the most in taking a tools and equipment class based on the data. However, it is safe to say that the earlier CM students take this class the more likely they would excel in their internships regarding job progress and equipment safety.

Interview

One of the first questions I asked John Tuttle was if he felt that “the interns or fulltime new hires that come to work for Webcor have adequate tools & equipment experience?” He responded with “absolutely not, but how could you expect them to do so when tools and equipment are constantly changing.” He describes how the jump from plugin to battery operated equipment was a huge leap in the construction industry. He also explained that currently, with devices like remote control robots that can go down 100 plus feet of pipe to identify issues in the field that the crew can’t get to, construction technology is evolving faster than ever before. He makes it clear that in order to get most out of this class it is essential that the content stays up to date with current trends in the industry.

Since contractors are having to adapt to various tools in the industry, John thought it would be best to think about this class as a more research and development driven course. He informed me of some of the latest technological advancements that he has taken notice of. One major addition to health and safety on the jobsite has been a new vacuum and filter that has been designed to attach to tools like rotary hammers in order to collect silica dust created from drilling into concrete. Another concept, still in its inception but with great promise, are stationary rotary hammers that can attach to scissor lifts. This would make it so that laborers don’t have to worry about exhausting themselves by having to carry a 20-pound rotary hammer when they have to drill 1000 holes in one day, they would simply have to focus on positioning the lift in the appropriate spot.

When I asked John whether I should include OSHA safety tools and equipment content he was quick to agree with me. His opinion was that most interns and new hires think that efficiency is of the utmost importance and that it can be easy to identify one tool from another when solely looking at how productive it is. However, he was on a job where a laborer was drilling holes with a rotary hammer and ended up lacerating his finger because it got caught in a drill bit. Needless to say, it is extremely important to keep safety as the number one priority and efficiency second when choosing tools. This was his argument for the types of OSHA related questions I should recommend for such a class.

John’s final suggestion to my idea for a tools & equipment class was that it should be structured to go over a different category of tools every week. Week 1 could be fall protection, week 2 could be tools for carpentry, week 3 could be equipment for grading and so on and so forth. I thought that this was a genius idea as for how to categorize the content of the class. Originally, I was thinking breaking it up by industry but after speaking with John, and looking at Matthew Bramlett’s course syllabus, going over a specific set of tools for a specific set of tasks is a much more effective way of covering the widest range of tools.

The main takeaway from this interview was that tools and equipment technology isn’t static, it is constantly changing, and the construction industry is always forced to adapt with it. By keeping safety and efficiency in mind throughout the progression of the class it is essential so that students will be ready for what they will eventually be managing in the field. Finally, in order to get as much of the material through to the students taking the class its structure should follow various tasks that are covered in nearly all areas of our industry.

Conclusion and Future Research

Based on all of the information gathered in the survey and the interview, a construction tools and equipment class of this nature would be highly beneficial for all students seeking a degree in construction management. Turning this class into a technical elective course would be the best option, at least initially, so that the faculty can establish

whether a class of this nature is actually feasible and if it is popular enough to continue to be a functioning class in this department. For a degree in construction management at Cal Poly it is required that students take at least eight technical elective units in order to graduate. This means that if this class was a technical elective course it wouldn't be required to complete a CM degree but if there is enough content for the class, the structure of it meets the department's requirements, and the faculty approve of the courses effectiveness then it is possible the class could end up being a standard, mandatory class in the department.

The fact that the average correct responses of all students who took the survey was approximately 6, with hardly any variation between the situational based questions and the safety related questions, it is clear that an OSHA-30 certification course as an outside of class objective would be an easy way to ensure that student's taking this course can acquire appropriate safety related tools and equipment knowledge without the professor having to know a tremendous amount about the safety related topics since all of the information would be online for the students. However, the biggest hurdle to implementing the OSHA-30 Hour course is going to be the cost. On the OSHA education center website, the cost of the OSHA-30 Hour Training for Construction class is \$179.00 (American). This is problematic considering most textbooks that we are required to purchase for classes in the department are less than \$100 dollars and, being a college student myself, I wouldn't want to take a 2-4 unit technical elective course that requires that I purchase a training course that is this expensive. A couple ways to help reduce this cost would be if the CM department partially subsidized the cost of the training course so that students would be more open to taking this class or if OSHA would be able to grant the department a discount.

As discussed in the introduction, Patrick Garcia's survey that he sent out for his senior project was enough to convince me that an OSHA-30 class wouldn't only have high demand by construction management students at Cal Poly but it would also help fill some of the voids that are present in the current CM curriculum involving tools and equipment safety. While he found that only 4% of students have completed their OSHA-30 Hour training course the implementation of a tools and equipment course would be able to help increase that percentage and, in doing so, make that percentage of students more desirable for all professions in the construction industry.

While the majority of homework for this class would be the OSHA-30 Hour Training for Construction online course, how exactly is this class going to be structured on a weekly basis? Based on Matthew Bramlett's course syllabus that he created for their OSHA-30 topics course concept and the interview that I conducted with John Tuttle, the optimal class structure would have specific topics that cover all industries in construction. Since many tools that are commonly used in commercial, residential, heavy civil, and specialized construction tend to overlap, covering topics like concrete or soil for a week would cover the greatest range of tools and equipment for specific trades. I have developed a potential weekly schedule for this class below:

- Week 1: Fall Protection
- Week 2: Carpentry
- Week 3: Concrete & Masonry
- Week 4: Steel
- Week 5: Grading
- Week 6: Excavation
- Week 7: Cranes
- Week 8: Soil
- Week 9: MEPP
- Week 10: Technology Presentations

This topics outline draft could be altered to incorporate a variety of other tool and equipment applications. However, I felt that this weekly class structure breakdown included the most significant tools and equipment that are used on most jobsites today. As mentioned in the interview, construction technology is ever changing and as such the content of this course should be changing with it. Therefore, I decided to have "technology presentations" for this class. How this will work is that during week 1 of the course the teacher will place students in groups of 2-4, depending on

class size, and each group will have the option to pick a new invention or concept that is sweeping the construction industry. This invention or concept must be related to tools and equipment for their presentations at the end of the quarter. An example could be a new software for drones, an attachment or modification to an existing tool, or a new tool that is currently being tested. Once a group identifies their topic the next step is to create a presentation talking about what the purpose of the invention or concept is, how it is being used today, what are its various applications and what construction industries will it affect. These presentations will allow students to stay up to date with current technological trends in the construction industry while still being able to learn about basic tools and equipment throughout the quarter.

Ideally this class would have a laboratory section where students would be able to use tools such as rotary hammers, angle grinders, portable bandsaws, etc. The main issue with having a lab section to this class would be obtaining all of the necessary tools and equipment for it. Certain weeks in the course outline would be easier to include a lab than others, such as carpentry or MEPPF, because we already have many of the tools for these topics in the Simpson Strong-Tie (SST) building on campus, which is utilized for residential and commercial construction classes. Discovering a means of getting more tools and pieces of equipment to the SST would be essential in order to effectively conduct a lab for this class. This might be possible by having supervisors or foreman that are local to the area come out to the SST courtyard with any tools and equipment we might not have and demonstrate how to properly use it to the class.

All of the preliminary ideas and concepts for this class are up to interpretation and are certainly not set in stone. One of the major future research techniques that would be crucial in detecting the feasibility of the class in more detail would be to construct a complete course syllabus like the one Matthew Bramlett wrote for his senior project. This would allow a more detailed outline of the class, going more in-depth on course goals, and learning objectives. Another idea for further research concerning this class would be another survey that would assess how much tools and equipment knowledge students are gaining through their internships and asking them what important practices they learned were and how they could be included in this class.

Tools and equipment are utilized every day in the construction industry, and it is the responsibility of all parties involved in the process, from laborers to project managers, to fully comprehend all the risks and benefits associated with them. We cannot expect jobsites to run smoothly if we do not take the time to understand how tools and equipment impact our industry through safe practices and proper application. An introduction to Construction tools and equipment course at Cal Poly would be a tangible means of mitigating the gaps in construction technology that are not being taught today. The benefits of such a class cannot be understated in a business that has only recently started to make safety a primary objective and that is constantly striving for more efficient means and methods.

References

American Safety Council, (2019) OSHA 30-Hour Training Courses. [WWW Document] URL, <https://www.oshaeducationcenter.com/osha-30-hour-training/>

Bramlett, M. (2018) “*OSHA-30 Interactive Laboratory Course*” [WWW Document] URL, <https://digitalcommons.calpoly.edu/cmisp/201>

Garcia, P. (2018) “*OSHA-30 Lab Topics Course on Construction Safety and Hazard Identification*” [WWW Document] URL, <https://digitalcommons.calpoly.edu/cmisp/192>

MySafetySign, (2019), Hand And Power Tools Quiz. [WWW Document] URL, <https://www.mysafetysign.com/hand-and-power-tool-safety-quiz/questions/how-do-you-tighten-a-nut-with-an-adjustable-wrench>

ReliablePlant, (2019) Hand Tool Safety Quiz. [WWW Document] URL, <https://www.reliableplant.com/Read/233/hand-tool-safety>